An Approach To Command and Control Using Emerging Technologies
ICCRTS – 044

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As technologies emerge they must somehow be brought (accredited, tested) to the battlefield. As new technologies come to the battlefield the methods of command and control must be adapted to accommodate these new technologies and the information sharing they enable. Additionally, the traditional command and control paradigm must be changed to account for new capabilities. When new information types and sources are made available legacy systems must be able to efficiently interoperate with or relay the data to key decision makers. The RISA team at the Air Force Research Laboratory has investigated these command and control issues with the introduction of the Android based application for ground users ATAK, and the airborne Marti information management server. Additionally, the RISA team has made enhancements to existing command and control capabilities through the interaction of ATAK and Marti. Through working with human factors experts and tactical radio network users, the RISA team has found that adding the mobile computing platform to the tactical command and control infospace has significantly shortened the kill chain for tactical operations, as well as reduced the likelihood of fratricide in combat.

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Abstract

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Body

Operational Paradigm

Cursor on Target (CoT) has been a recognized military protocol since 2007 and had been in use since 2002. CoT is usually implemented as an XML schema and small messages are easily transmitted over internet protocol (IP) networks quickly. In the past 10 years CoT has proven itself to be a viable and effective means of communicating in disadvantaged networks like fielded tactical radio networks. With the emergence and proliferation of new tactical radios capable of transmitting internet protocol (IP), a mature capability for shared digital data now exists at the tactical edge.

The RISA team at the Air Force Research Laboratory has fielded several versions of the Marti Information Management Server (Marti). The core operating model is one of a single server in the field (frequently running on an aircraft) with multiple clients both in the air and on the ground. The server and the clients take advantage of IP based tactical networks and rely heavily on the CoT protocol to communicate in the tactical environment. User demand for the capabilities offered by the Marti server and related CoT enabled ground clients have driven development of applications to leverage these emerging technologies for military use.

Marti Server

The Marti server is the central hub of our command and control infospace. It is a software process usually running on a spare computer in an aircraft or more frequently in an attached pod. The server archives and disseminates all data it receives in a “subscribe-publish -query” fashion. Traditionally

sensors operate in a “sensor-push” mode. That is, the sensor generates data and publishes the data with no regard for its quality or any user demand for the data. Marti allows a change from “sensor-push” to “demand-driven push” or “consumer pull”. This change is a critical shift in tactical network bandwidth usage because oftentimes sensors are configured to capture a great deal of data and publish it over a tactical link that has neither the bandwidth nor the user demand to warrant publishing. Moving to a demand-driven sharing mechanism means more efficient use of bandwidth, and allows network users a measure of configurability as they subscribe to certain feeds. Critically, under the “consumer-pull” or “demand-driven push” only the most important or useful actually data consumes bandwidth.

Marti also provides a data repository that can be queried for past data as well as store full size data sets while disseminating smaller versions of the data across the network (e.g. archiving an entire image while sharing a thumbnail). When users publish data into Marti, the server reacts by archiving the original data and notifying all subscribers that new data has been received. In the image example, Marti receives an image either embedded in a CoT message or in native format from some sensor. The original image is archived and a CoT message with a small (100x100 pixel) thumbnail is generated. That thumbnail is then embedded in another CoT message and shared to all subscribers. The bandwidth saving is obviously a function of the size of the original image, but in typical use cases this thumbnail is less than 1% of the size of the original. Under the old operating paradigm, the sensor would have broadcast the full-size image directly and it is unlikely that any subscriber would have received it. The repository is currently implemented with a CoT interface to a PostGis database, which is a change from Berkeley XML DB. Berkeley was originally used because CoT is an XML schema, and Berkeley XML DB made sense. The geospatial awareness of PostGis allows users to query the data using complex spatial parameters and expect results back in a reasonable time that Berkeley simply is not designed to handle, however. Typical use cases of complex spatial shapes are routes specified as polylines. Our users have several digital map tools that allow them to mark up routes as polylines. The ground client can then take that route and convert it to a Marti query and pass the route vertices into PostGis with a given perpendicular distance from the route. In several tests made against Berkeley XML DB a 60 mile route could take as long as 10 minutes to evaluate. When running the same test against PostGis results were returned in less than 8 seconds for the same route. In fact, he query execution time was comparable to the network latency of many tactical networks.

Additional Information Management (IM) capabilities that Marti offers are quality-of-service (QoS) related. Humans in the loop can decide if certain message types should be given higher priority than other types, or if certain publishers’ data should be shared before other publishers’ data. Another case of bandwidth saving was at a recent exercise and users put a filter on Marti to not disseminate any image of the ground not near nadir. This resulted in roughly 85% reduction in message traffic simply because of a basic QoS configuration.

Since image / map data sharing is such an important capability in the tactical space, another sought after feature provided by Marti is the image chipping feature. This feature allows users to request smaller pieces of map imagery from a larger tileset. The user marks an area on their digital map (Android or FalconView for Windows) and a CoT tasking message is generated. Marti accepts the tasking message, examines its database for map data lying in the region of interest, and chips out the region of interest

and sends it back to the requesting client. Because CoT is an XML schema it is necessary to base sixty four encode the images resulting in message size inflation by about 33%. This is of course undesirable, particularly on disadvantaged radio links, so in the return CoT message HTTP links are provided so the client may download the chips from the server over HTTP.

Similar to the image chipping option, Marti can also serve up video in user requested segments. Again, publishing entire video files or streams over tactical links can flood these networks and render them useless. Marti has successfully run downstream of several airborne sensors and archived the video they produced. Marti then pulls out individual frames every few seconds (this is a configuration option, usually a frame every 1-5 seconds is sufficient) and publishes small stills embedded in CoT messages as thumbnail sized previews. With Marti in place as a buffer, no video is published unless a user requests to see that video, and video can be resized / encoded on the fly to adapt to network conditions. Additionally, users may request via HTTP a segment of the video stream. Sometimes a 5-30 second clip is all that a ground user requires, and Marti supports serving up segments of the video stream as files.

Android

Historically, the human interface to an IP based tactical radio network has been a laptop computer carried into the field by a soldier. Efforts have been made to reduce the size, weight and power and increase the durability of laptops intended for field use. The recent surge in tablet based computing in the public sector has led to an increased demand from the tactical user community to move to tablet or even phone sized computing hardware. This move poses challenges in the areas of human factors, software development, training and hardware integration.

The goals with any human interface into a tactical network are a) provide a clear, meaningful picture of the situation on the ground b) reduce size, weight and power of equipment carried by soldiers and c) eliminate or reduce the configuration burden for end users. Mobile computing technology is mature enough today to meet the processing and data sharing requirements held by tactical users while meeting these three requirements. The Android Operating System (OS) provides a viable open-source solution as it is modifiable and relatively easy to develop against. The choice of Java as the primary development language means a large user community stands behind the OS to offer enhancements and fixes as well as large amounts of existing application code.

Other mobile computing OS's were considered, particularly iOS and Windows mobile. Neither OS is particularly open nor modifiable, however; and the decision to move ahead on Android was not a hotly contested one. NSA has reached the same conclusion the RISA team did, and adopted Android as the basis for the government's secure mobile devices. [1]

The Android Tactical Assault Kit (ATAK) is the human interface solution the RISA team proposed and executed initially on Android 2.1. Primarily an OpenGL ES based map application; ATAK supports numerous features needed by the tactical user community as well as a software architecture that is extensible in several ways. In addition to being a map, native CoT support was the first requirement

users had. ATAK supports full 2525b military standard symbology as well as the ability to parse and display CoT messages directly from the network.

When Android 2.1 was released, the OS had difficulty loading classes from .jar files are runtime. ATAK still had the requirement to be flexible, so the RISA team set about searching for a means of building in extensibility without the need for every developer who wants to add functionality to recompile ATAK from source. The team found that a Javascript (JS) based plugin framework was possible. The plugin framework relies on native Java objects being passed to the Android JS engine. These Java objects are hooks for JS to call the map and draw items, plot CoT messages and the like while also acting as callback channels so that the map engine can notify the JS framework of changes to the map. These native Java callbacks also allow the JS framework to request network and file access, as well as access to the Android Intent messaging framework. JS typically is not allowed access to network and file resources because such access poses an obvious security risk. The RISA team understands these risks, and allows only JS files located on the SD card in a special “plugins” directory to be granted these special privileges. In the end, a “plugin” consists of a any number of HTML and JS files in a subdirectory of “/<SD_CARD>/<ATAK_ROOT>/plugins”. A WebView embedded in ATAK displays the index.html file present in the folder and the necessary Java binding objects are passed to that WebView instance. There is no interface to point that WebView at a remote URL, and logic in the ATAK application code prevents the WebView from loading any link not in its plugin directory.

To date ATAK supports 9-line call for fires, parachute jump planning, mission route planning, video / image viewing, text based geo-located chat and the JS plugin framework. These capabilities are critical to our user community and would not have been implemented without their direct request.

The ATAK and Marti source is full unlimited government rights code and RISA is free to distribute the ATAK and Marti software on request. Both technologies are fielded and in active use by combat units. RISA receives continuous feedback from this user community and is adapting our application capabilities to meet the latest needs in the field.

References

[1] http://www.nsa.gov/ia/programs/mobility_program/index.shtml